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Reviews.

The Age of the Second Terrace on the Ohio at Brilliant, near Steubenville.—The inquiry raised by Professor Chamberlin, in his comments (Journal of Geology, Vol. IV., pp. 107–112) upon the age of the gravel at Brilliant, Ohio, in which Mr. Huston's discovery of an implement was made, is both pertinent and important, and certainly calls for a more specific statement of my reasons for believing that its deposition was substantially synchronous with that of the 130-foot terrace at the mouth of the Beaver, about fifty miles above it, concerning whose age there is I believe, no question. Of course the only absolute certainty in the case is that at the time of the deposition of the gravel at Brilliant the floods in the Ohio River at that point reached a height something more than eighty feet above the present low-water mark. This the character of the cross-bedding actually demonstrates. The evidence connecting it with the 130-foot terrace at Beaver, while of a more general character, is still, I think, convincing.

In the first place, Professor Chamberlin's remark that there are terraces on the river above and below Brilliant that reach 120 and 130 feet above low water, while the implement-bearing terrace reaches only 80 feet, though literally correct, conveys a false impression without a fuller statement of the facts. The nearest 130-foot terrace above Brilliant is that at Beaver, where a powerful glacial tributary came into the Ohio overloaded with terrace material. From that point down to Brilliant the terrace, though practically continuous on one side or other of the river, gradually diminishes both in height and in coarseness of material, and never rises more than 102 feet above low water until reaching Portsmouth, two or three hundred miles below, where the Muskingum River, the first glacial tributary below Brilliant, joins the Ohio. Here the terrace rises 110 feet, while at Cincinnati, below the junction of the Little Miami, the terrace for the first time jumps again to the 120-foot level. The smaller height of the terrace at Brilliant, therefore, is readily explained without the theory of its having been worked over.

It should be noted, also, that the locality where the implement was found is near the west side of the trough of the river, whose entire width is here fully one mile. This is just one of those positions, therefore, in which we might look for a diminution both in the original height of the terrace and in the coarseness of its material, since all rivers in building up a flood-plain deposit the coarser material near the main current, and consequently build up the plain higher there than on the margins. I see therefore no reason to be shaken in my conviction that the terrace at Brilliant is approximately as old as that of the 130-foot terrace at Beaver, but it is a question to which I trust specific attention will be given by others. G. FREDERICK WRIGHT.

OBERLIN, Ohio, February 15, 1896.

Place is cheerfully given to the foregoing as it is helpful in bringing out more precisely and amply the question of the age of the terrace at Brilliant. It is also helpful in making additionally clear the fact, urged in the review, that the age of the terrace is an open question of interpretation rather than a firm conclusion based upon substantial demonstration. The brief statement of the review was unquestionably inadequate, but its defects were, we think, less favorable to the grounds of doubt urged by the reviewer than to the grounds of belief entertained by the author, as will perhaps appear from further consideration of the case.

A rigorous discussion of the question would necessarily be lengthy and would require data as yet undetermined, but a few of the more obvious considerations necessary to a safe interpretation may be briefly indicated.

The view entertained by Professor Wright that the glacial filling would naturally be highest at the mouths of the main streams which came down from the edge of the ice is not an improbable one, though not necessarily the only one. The conception involves a series of sudden rises in the river bottom at the mouths of the tributaries followed by declines below them; in the present case, a rise to 130 feet at the mouth of the Beaver River; a decline down stream to some unknown level below 80 feet; another rise to 110 feet at the mouth of the Muskingum River, a second decline, and again a rise to 120 feet near the mouth of the Little Miami. The case is really more complicated than this, because it involves the deposits of the Scioto, Great Miami and minor streams, but this is immaterial for present purposes.

Now what would be the normal history of a stream bed filled in this rythmical fashion, when the source of special supply was cut off? Obviously erosion must have begun on the crests of the high deposits. The material so eroded must have been carried forward and *deposited in the lower stretches* just as material is now being deposited in the bottom of Lake Pepin, whose existence is attributed to the deposits of the Chippewa River that enters just below it. Clearly the eroded material could not be carried over the next rise until a common degradation gradient for the whole section was established. A period, therefore, followed the close of the glacial action during which the high deposits were cut down and *the low deposits built up.* In the present case the Beaver deposits were presumably cut down and the Brilliant deposits built up.

How long this period continued it is impossible to estimate accurately, for it was dependent on several uncertain conditions. (1) From the very nature of the hypothesis, it is impossible to determine what was the status of filling of the low parts at the close of glacial action. Almost any degree of filling or lack of filling may be assumed. (2) The retarding effects of the Champlain depression are quite unknown. (3) The deposits in the valleys of the glacial tributaries participated in the action to an undetermined degree. As soon as the high deposits at their mouths began to be cut down, their gradients, already high, would be increased and their material would be carried into the main stream and would check further degradation until it was disposed of. It was even possible, under certain conditions, for these tributaries to continue to build up the deposits at their mouths after the cessation of glacial action.

How much the Brilliant terrace was built up during the establishment of a common plane of degradation seems to be quite indeterminable. Taking the present Ohio as a basis of reference, and supposing the surface of the Brilliant terrace to represent the plane of equation (neither of which is beyond question) there were heights of 30 to 50 feet, in addition to the contributions of the tributaries, to be brought down, and the low parts to be built up from unknown depths. The shallow depth of the implement, eight feet, seems a very modest figure to assign as the possible, or even probable, upbuilding of the Brilliant deposits.

There is still another item in the history. After the establishment of the plane had been accomplished, there was a temporary stage of equilibrium in the parts built up, followed by the initial stages of degradation. In the degradation of such a plane the material is not taken up once for all and carried out to the sea (except of course that held in suspension), but is shifted little by little through cutting here and filling there, until, piece by piece and shift by shift through almost endless repetitions, the material is at length transferred to the sea. The newly formed portions of the equated plane would be liable to suffer this process over their whole surface during the stage of equilibrium and the early stages of degradation. It would be only when the degradation of the portions down stream had increased the gradient to such an extent as to lead to a contraction of the channel and the abandonment of a portion of the flood plane, that reworking of the surface parts would cease.

If, therefore, we assume the style of fluvio-glacial deposition postulated by Professor Wright, we find definite reasons for regarding the upper part of the Brilliant deposit as postglacial in origin, and find moreover special conditions that may have subjected it to reworking during the early stages of degradation that followed its construction. If, on the other hand, we assume that the glacio-fluvial deposits took the form of a common aggradation plane at the close of glacial action, the presumption is that the Brilliant terrace was carved out much later. It is just possible that the Brilliant deposits happened to be at the pivotal point between degradation and filling, and so were original—and the review admitted that they might be—but the more the case is studied the less probable this seems. T. C. C.

North American Fossil Crinoidea Camerata. By CHARLES WACHSMUTH and FRANK SPRINGER. (Memoirs Museum of Comparative Zoölogy.) Two parts, 800 pages, and atlas of 83 plates. Cambridge, 1895.

During the decade just passed our knowledge of ancient organisms has been enormously expanded, not so much through the old grooves of endless multiplication of species, as along lines in which the most recent conceptions of morphological inquiry are taken into consideration; or along lines having a direct bearing upon the interpretation of geological phenomena. Hence the differentiation of modern palæontology has been chiefly in two directions, and these departments are becoming so widely divergent that they will ere long, if some energetic steps are not taken to prevent it, cease to be of mutual aid. The